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FACILITIES AND ENVIRONMENTAL EFFECTS  
SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
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PANEL SP-4

DESIGN/PRODUCTION INTEGRATION

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Overview of Panel SP-4, Design Production Integration 1985

by

F. Baxter Barham, Jr.

ABSTRACT

Panel SP-4 is seeking ways to assist U.S. Shipbuilding attain and maintain a worldwide competitive position in Time-Cost-Quality. The work of the panel addresses the detail design and planning efforts, integration of those efforts into the production process and the tools involved.

During the past year the panel pursued its goal through the publication of a report on "Software Tools for Shipbuilding Productivity", completing work on a "Design for Production Manual" to be published this quarter and the continuation of efforts on systems of classification and coding and computer aided process planning suitable for the shipbuilding environment. In addition, work has just begun on five new projects involving a broad spectrum of shipyard disciplines. Also, another year's work has been laid out involving four shipyards and two universities. Finally, the panel is establishing interfaces and developing a program on Navy-Industry computerization intended to address the findings and recommendations in the National Research Council's report, "Toward More Productive Naval Shipbuilding".

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## INTRODUCTION

This overview of Panel SP-4 is intended to provide a report of the panel's work over the past year. It will begin with a brief statement regarding the panel's philosophy and purpose (BACKGROUND) in order to provide a baseline against which progress may be measured. The work done during the past year will then be presented under the following headings:

PROJECTS COMPLETED

PROJECTS UNDERWAY

PROJECTS FOR THE FUTURE

PLANNING

All projects listed under the categories noted above have been approved by the SNAME Ship Production Committee (SPC) and those shown as completed or underway have been funded via a Maritime Administration cost sharing contract with Newport News Shipbuilding. Each of these projects (those completed or underway) have been subcontracted by Newport News Shipbuilding to the project sponsor noted. Projects for the future are a part of the panel's program proposed for fiscal year 1985 which has been submitted to the Maritime Administration for funding. Funding is expected this month.

The section headed PLANNING is devoted to SP-4's involvement in preparations to enter the most important and necessary area of cooperative research and development that we face today; Navy-Industry Computerization. The challenge has been laid out in the National Research Council's report "Toward More Productive Naval Shipbuilding" and SP-4 has been working with the SPC, the Ship Design Committee and the Navy to formulate a response.

## BACKGROUND

Panel SP-4, Design Production Integration, was established by the Society of Naval Architects and Marine Engineers' Ship Production Committee in April 1981 and its program was first funded via a MarAd contract with Newport News Shipbuilding on July 30, 1982. While Newport News continues to sponsor the panel, the panel's work truly reflects industry wide input and participation. Project selection involves the entire panel membership which represents,

13 Shipyards  
4 Universities  
3 Design Agents  
4 Government Offices  
1 Non-profit Research Institute

Shipyards represented by the SP-4 membership have the capability to build, overhaul or repair any ship the customer might want from wood hulls to huge tankers to the most sophisticated warships afloat.

It should be noted that the program developed by this broad industry representation has resulted in projects worked, being worked or scheduled to be worked in the coming year, by the following mix of organizations:

Avondale Shipyards, Inc.  
Bath Iron Works Corporation  
Bethlehem Steel Corp. - Sparrows Point Yard  
Ingalls Shipbuilding Division  
Newport News Shipbuilding  
Todd Pacific Shipyards - Los Angeles  
Todd Pacific Shipyards - Seattle  
A University and Shipyard to be determined

All projects will be required to produce generic results which will be documented and the documentation given wide distribution for the use and benefit of the entire U.S. Shipbuilding industry.

The diverse group described above, which is panel SP-4, does have a common purpose. Panel SP-4 is seeking ways to assist U.S. Shipbuilding attain and maintain a worldwide competitive position in Time-Cost-Quality. Its contribution involves the interaction of design and production personnel and, as seen above, representatives of owners (Navy), government agencies, design agents, universities and shipyards. Also, its contribution is through the realization that:

- Design is the first step in, and an integral part of, the production process.
- Integration of the production process involves the application of computer technology to the design and manufacturing disciplines.
- Products must be designed for ease of construction as well as superior performance.

Simply stated, the work of the panel addresses the ship detail design and planning efforts, integration of those efforts into the production process and the tools involved.

The areas of concern, the premise on which the panel is founded, and the panel's approach to its task has led the panel to accomplish much through its program as outlined below.

## PROJECTS COMPLETED

### Software Tools for Shipbuilding Productivity

This project was worked by Grumman Data System Corporation under subcontract to Newport News Shipbuilding. The following quote from the executive summary of the project report provides insight into how the project was worked as well as the subject matter covered.

"The objectives of this study are to define and identify software tools, and to impart to the shipbuilding community the knowledge to use them to aid in the design/production integration of the shipbuilding process. The approach taken in this study has been to:

- Research, review and define the CAD/CAM integration process
- Develop selected scenarios of modern CAD/CAM integration methods
- Isolate and research software aspects of CAD/CAM scenarios; select and list application areas for software tools to (potentially) increase productivity for the integration process defined
- On-site visits to shipyards to review prepared CAD/CAM scenarios and software tools to define applicability of technologies, need for changes and knowledge-level of potential users
- Collect, reduce and review data from on-sites visits
- Create a scenario adapted to the real-world of shipbuilding; identify critical software needs and select useful software tools
- Select a shipbuilding scenario and determine software needs to actually generate the integrated system; outline a means to calculate potential savings through the use of software tools.

The material presented is ordered as outlined, and is followed by a catalog of software tools, and a recommended means of distributing results to the shipbuilding community. A glossary of acronyms is also included...

This report has as its focus, the identification of CAD/CAM integration requirements and software tasks required to support them. The categorization of these software tasks into logical steps amendable to increased productivity by application of specific software tools is the end product of benefit to the shipbuilding community. Tools and the knowledge to use them, in this case for increased CAD/CAM

software productivity in the shipbuilding design/production process, is the theme of this report."

The final report was distributed January 8, 1985, is now in its second printing and has been distributed to over 120 persons across the United States and Canada. A limited number of copies are still available from F. B. Barham, SP-4 Chairman, Newport News Shipbuilding.

## PROJECTS UNDERWAY

### Design For Production Manual

This project is sponsored by Bethlehem Steel Corporation, Sparrows Point Yard with the cooperation of J. J. Henry Co., Inc. and utilizing the consulting services of A&P Appledore Ltd. of the United Kingdom. The project is being worked in three phases as follows:

I      Definition of Requirements

II     Production of the Manual

III   Dissemination to the Industry

Phase I is complete and we are nearing the end of Phase II. The manual, which will be published this quarter, will be in three volumes intended for use by implementing managers, design engineers, planners and production and industrial engineers. The first volume will cover Concepts, the second will cover details of Design Production Integration and the final volume application of Production Engineering.

The manual outlines and explains the basic concepts of design for production, translates these concepts into practical applications and provides implementation guidelines. However, the manual is not intended to be a stand alone cure all for U.S. Shipbuilding. It is viewed by the panel as a developing tool both in the sense that it will act as a catalyst in the thinking process necessary to develop and implement design for production concepts and also it will be dynamic and continuously expanding in detail and scope in logical stages based on the individual needs of the shipyards that use it.

The manual will be provided in loose leaf covers to accommodate supplementary data developed by the user, and perhaps reports from follow-on SP-4 projects.

## Product Work Classification and Coding System

Todd Pacific Shipyards Corporation, Seattle Division is the sponsor of this project. We are now in the last phase of a two phase project scheduled for completion by the end of June 1986.

This project is intended to investigate and provide a tool to increase productivity in U.S. Shipyards through the application of group technology principles to the unique features of shipbuilding. The unique features include:

- Hull structural fabrication and assembly
- Outfitting
- Surface preparation and painting.

The tool to be investigated and provided is a classification and coding system that will be computer compatible, usable with a computer aided process planning system and which will accommodate the application of group technology concepts to the shipbuilding features noted above.

The project has developed an attribute listing and a coding scheme which is now under review. When review is complete, portion(s) of an FFG 7, Class Frigate will be broken down into hull block construction, zone outfitting and zone painting work packages. The classification and coding system will be applied to the work packages to insure that all work involved in producing the test portion(s) of the ship can be coded by the system.

A two part evaluation will be made of the test results. First, a survey will be made to determine what percentage of the work was classified by the system. Work not classified by the system will be examined to discover system deficiencies.

Secondly, Todd, Los Angeles personnel will use the system to classify the work packages and a group technology consultant will evaluate the systems ease of use.

At the conclusion of this effort the coding and classification system will be modified to correct shortcomings discovered.

The final project report will completely describe the system development and application, explore its use with group technology and touch on related subjects such as computer aided process planning and cost collecting. The report will also include a glossary of terms and a literature file listing resource documents.

## Computer Aided Process Planning System

This project is sponsored by Bath Iron Works and is scheduled for completion by the end of the second quarter, 1986.

Process planning is the selecting and sequencing of manufacturing processes and resources. When applied to shipbuilding, the process planning function is complicated by the size of the task, the complexity of the product and the mix of processes. This project will attempt to develop definitions of interim products and manufacturing processes to the point that the project can then select and demonstrate the application of a computer aided process planning system (CAPP) for shipbuilding. Such a system will increase the speed, repeatability and accuracy of the planning function as well as facilitate the planning required to obtain the advantages of group technology in shipbuilding.

The project's scope includes the evaluation of existing commercially available CAPP systems for suitability in the shipbuilding environment. If a particular system is found suitable, it will be tested at Bath Iron Works and a recommendation on its use will be made based on the test results. In event no suitable system is found, phase II of the project will develop a Shipbuilding CAPP System Specification suitable for obtaining fixed price bids for required software and hardware. The project sponsor will circulate any specification so developed to other interested shipbuilders prior to publication.

Close liaison has been established between the CAPP project and the classification and coding project previously outlined. This is an example of a case where cooperative research can yield synergistic results.

#### Required Content and Format of Engineering Documentation

This project is sponsored by Avondale Shipyards, Inc. and has just begun. Completion is estimated to be by the end of the third quarter, 1986.

Historically, drawings provided to production personnel have been system-level drawings containing all the information needed by all personnel within the shipyard, as well as the ship's operators. The format has been large, rolled or folded drawings.

Today the trend is to provide drawings, material lists, and other documentation which contains only the information needed by personnel at a specific point of construction. In some cases, in the use of numerically controlled machines, certain types of drawings or information may be eliminated or satisfied by tapes or direct computer input to the machine operators. Booklet-type drawings are being implemented in some applications and may be suitable for others. Some information may be better transmitted and read on computer tubes than on paper copy.

The project task group is developing an approach to be used by participating shipyards in assessing the specific information needs at each stage of the production process and in identifying the optimal technique for providing that information. This methodology will be tested by application at each of the participating shipyards. A report will then be prepared by the task group, which will be usable by other shipyards in carrying out similar studies.

#### Information Flow Requirements for Design/Procurement Processes

This project is sponsored by Ingalls Shipbuilding Division. Completion is estimated to be during the second quarter of 1986.

In this project we intended to identify and investigate the controlling and interfacing data needed by the engineering and procurement organizations and develop a system of data acquisition and exchange designed to allow the shipyard to perform the design and procurement functions more nearly concurrently in lieu of sequentially.

Data required by the engineering and procurement organizations will be identified, the point in time that the data is required will be established, and the extent of detail will be determined. Support requirements (spares, training, etc.) will be considered. Flow charts will be used to aid in developing the time phasing aspects of data acquisition. Vendors will be queried so as to use their input to the design/procurement process evaluation. Use of computer data transfer will be investigated.

A formal report including flow charts, dependency networks, problem discussions and recommended methods will be published upon completion of the project.

#### Interface Impacts - System to Zone Transition

This project is sponsored by Todd Pacific Shipyards, Los Angeles, and is scheduled for completion by the middle of 1986.

Here we have the opportunity to study two Naval combatants of the same class, built at the same shipyard; one by the system method and one by the zone method; and identify the impacts of the transition on the shipyard and its systems and functional areas.

Todd has formulated a well rounded team of engineers, planners and production management personnel suited to thoroughly analyze and document the before and after conditions. The team has been directed to look objectively at the process of ship construction using a recent FFG 7 Class Frigate as a case study. The team is to identify the impacts of

changes on overall productivity as well as determine the sources of problems that stemmed from advanced outfitting. It is also to recommend actions that will prevent the problems identified and which will result in cost reductions.

The Todd team will approach its work as outlined in the four following tasks:

Task 1 Break down original systems oriented design drawing to show:

- Zone/Workstation assignments
- o Zone Material Requirements
- o zone Estimated Normalized Manhours
- o Normalized Cost by Blocks, rather than by system

Task 2 Describe the cost effective ship construction measures used.

- o Drawing organization by zone
- o Measurement of physical production throughout

Work Stations  
Process Lanes  
Process analysis by throughout to develop optimized work station loading, departmental and shop floor methods.

- o Scheduling examples of assembly, outfit and erection
- o Modular construction work orders
- o Sequencing outfitting from different crafts
- o Material Requisitioning procedures
- o Isometric sketches from CAD/CAM system
- o Quality Assurance

Statistical control

- Kitting/Palletizing of material

Task 3 Determine the impacts of zone outfitting methods on production engineering and production processes.

Task 4 Produce computer graphics models of each hull block studied, using different levels (overlay style) for each subsystem. (i.e. structure, piping, ventilation, etc.) Show use of graphics to assist in interference control and outfit sequencing.

#### Develop a System for Specification Driven Pipe Arrangement Drawings and Pipe Details

This project is being sponsored by Ingalls Shipbuilding Division and is scheduled to be completed during the second quarter of 1986.

This project is to develop the architecture for a CAD system which will produce piping arrangement and detail drawings conforming to the correct material specifications and diagram configuration. CAD technology and an appropriate data base will be used to discipline and insure consistency between piping system drawings and, system diagram configurations and material specifications, thus reducing errors in piping design as developed from contract requirements.

The developed system will be tested using Ingalls' inhouse CAD systems and data for ships currently under contract there. Two piping systems will be used for test purposes; one an inter-compartment system such as the firemain system and one a system localized within one compartment or construction zone.

At least two turn key CAD systems will be investigated to insure that the architecture has been formulated to be independent of the specific CAD system with which it was developed.

The formal report will include the English language rules and instructions for selection of materials and conformance with diagrams imbedded in the system, architecture description and flow charts and text describing system techniques and method of application to the project. At least two technology transfer demonstrations will be presented on sight at the Pascagoula, Mississippi shipyard.

#### PROJECTS FOR THE FUTURE

The following projects, as previously noted, have been approved by the SNAME Ship Production Committee and proposed to the Maritime Administration for funding in fiscal year 1985. Each project has been investigated to the point that potential sponsors have been identified as shown below. Each potential sponsor must submit a detail proposal satisfactory to the panel's Project Review Board and the panel general membership prior to subcontract award.

Project: Investigation of Design/Planning Organizations  
Sponsor: Bath Iron Works

This project will examine alternative organizations used in design and planning departments and evaluate the advantages and disadvantages of each when applied to modern shipbuilding methods. Attention will also be directed to the short term transitional effects of adapting a recommended organization. The project report will include a recommended optimum organization for each product type observed during the study.

Project: study of the Application of Advanced Measuring Techniques to Shipbuilding  
Sponsor: Newport News Shipbuilding

This project will identify advanced measurement techniques supporting the process requirements of modular construction, define the planning and procedures required for their use and specify, by shipbuilding process, the techniques found to satisfy measurement requirements in shipbuilding.

A joint study will be conducted by an appropriate university and the sponsoring shipyard. Measurement requirements will be defined at representative stages of construction relative to the requirements of current and future construction techniques. Market place and industry surveys will provide potential methods of satisfying specific measurement needs at each stage of construction specified. Operational characteristics such as required planning and feedback time frame(s) will be defined. The preferred techniques for providing needed measurements will be identified.

The university will provide the research personnel and facilities to conduct necessary literature searches, industry surveys and scientific evaluations. The participating shipyard will provide the shipbuilding environment necessary for the university to develop planning requirements and operating procedures involved with the use of the new measuring techniques. The participating shipyard will conduct appropriate reviews of the university's work.

A report will be prepared by the university for use by shipyards in assessing their needs for, and use of, various advanced measuring techniques.

Project: Interface Impact - Systems to Zone Transition - Phase I I  
Sponsor: Todd Pacific Shipyards, Los Angeles

This project will investigate the design products used for the basis ship in phase I of the project (FFG 7 Class Frigate) and using hindsight, suggest changes in the design and design products that would allow for more efficient block construction methods.

It is planned to use selective FFG erection blocks as a basis for the following:

- Reconstruct the conventional erection and outfitting sequence and identify work order tasks and allocated budgets to serve as baseline.
- Replan erection and outfitting sequences to reflect new on-unit and on-block construction methodologies in order to maximize the producibility of the selected modules.

- Analyze existing design to see if improvements in layout, configuration or standardization will further improve producibility.
- Compare findings against the Design For Production Manual to provide a basis for validation and comment.
- Recommend drawing format changes to support changes in erection methodology developed in the above effort.

A report of all findings including normalized statistics, graphics, photographs of areas studied and sample work instructions will be published upon project completion.

Project: Workshop on Management of Advanced Technology in Shipbuilding

Sponsor: To be determined via request for proposals.

Under the sponsorship of Panel SP-4, a university will assemble a panel of experts from academia, government and industry who will prepare and conduct a workshop for personnel of a lead shipyard. Recognized leaders in organization behavior, engineering and ship production will prepare and lead the workshop focusing on how to deal with the problems encountered in introducing technological change in a shipyard environment. Attendees will also explore the organizations and methods needed to identify and manage a viable and desirable technological change program, the identification and management of individual development projects and the resulting deployment and implementation of the new technology.

An Ad Hoc advisory group made up of members from Panel SP-4 and Panel SP-9, Education, will assist in the development and administration of the project. It is anticipated that the project final report will service as the basis for similar workshops at follow shipyards sponsored by Panel SP-9.

#### PLANNING

Panel SP-4 began a review of its long range plans at its meeting in New Orleans on February 6-7, 1985. Possible areas of need were identified and one stood out above all others: the necessity of a cooperative Navy-Industry effort to develop and apply computer technology to the ship design, construction and maintenance environment. The remainder of this report will cover our progress in addressing a mutually satisfactory and advantageous approach to Navy - Industry computerization.

The Navy asked the National Research Council in 1981 to identify promising technology developments having the potential to increase the productivity of U.S. shipyards. The ensuing multi-year effort was concluded with the publication of the NRC's final report

on the subject entitled "Toward More Productive Naval Shipbuilding" dated 1984. This report considered the advances in computerization to be of critical importance to shipbuilding productivity and specifically recommended development in the areas of:

- o Common Engineering Data Base
- o CAD/CAM Data Base Systems
- o Interactive Data Transfer
- o Management System Development

The report identified the industry - government cooperative effort known as the National Shipbuilding Research Program (NSRP) as an established and effective forum for research in the area of shipbuilding productivity. However, its examination of the NSRP program revealed a lack of significant effort in the specific areas noted above.

Panel SP-4 began its attempts to better define the needed development, and its role in the effort, with a March 4, 1985 visit by a representative group from the panel to Capt. John F. Leahy III, Program Manager for the NAVSEA Information Systems Improvement Program. This meeting was followed by a letter from SPC Chairman, Jesse Brasher to Capt. Leahy dated March 21, 1985 wherein Mr. Brasher noted that the Ship Production Committee should be one of the liaison points with the Navy in response to the National Research Council report's call for an industry - government task force on computerization. Mr. Brasher's letter also recommended that the SPC's contact point be Baxter Barham, chairman of Panel SP-4. Capt. Leahy's letter of April 29, 1985 responded to Mr. Brasher and accepted his recommendations.

Concurrently, and in an effort to provide the foundation for development of a proper program, the Ship Production Committee and the Maritime Administration (partners in the NSRP) arranged a mini symposium on the morning of April 30, 1985 to examine the existing and developing Navy plans for computerization. Panel SP-4 was invited to the symposium and was well represented by members from east, west and gulf coast yards as well as the Great Lakes area.

The SPC arranged for a special task force to meet the afternoon of that same day to formulate and recommend a plan of action. The SP-4 chairman served on the task force.

The task force led by Mr. R. W. Thorpe of J. J. McMullen Associates, Inc., included 15 members representing seven shipyards, three design agents, MarAd, NAVSEA and two consultants. The representation also covered the Ship Production Committee, Panel SP-4 and Panel SD-2, Computer Aided Design.

The task group's recommended plan of action was accepted the next day by the Ship Production Committee and included the following required action:

1. SPC form an Ad Hoc Executive Committee of key shipbuilding industry managers to review and approve industry computer based technology program plans and policies and to interface with Navy policy makers.
2. Panel SP-4, hold a workshop in June, 1985 to prepare a detailed plan.

Concurrently with, and independent of the above activity, the Navy considered the NRC recommendations and confirmed the need for work in the aforementioned areas of Navy - Industry computerization. This is documented in Assistance Secretary of the Navy Everett Pyatt's letter of April 25, 1985 to Mr. Lee Rice, President of the Shipbuilders Council of America.

With this background the SP-4 panel chairman conducted a workshop on June 11, 1985 to prepare a detailed plan as directed by the special task force report adopted by the SPC. An attempt was made to hold a workshop that included representation from a reasonable cross section of interested activities on the one hand while, on the other, limiting the size of the assembled group such that the complex subject could be adequately addressed. The result was a group of twenty people representing the following:

NAVSEA 507  
David Taylor Naval Ship Research and Development Center  
Shipbuilders Council of America  
NAVSEA 506  
Maritime Administration  
5 - Shipyards  
2 - Design Agents  
1 - Consultant  
Panel SP-4  
Panel SD-2

Still, it was felt that the task of developing a detail action plan responding to the National Research Council recommendation for

- o Common Engineering Data Base
- o CAD/CAM Data Base
- o Interactive Data Transfer
- o Management Systems Development

would be difficult to accomplish in a group large enough to represent concerned and affected parties. Therefore, the following four individuals were asked to collaborate in developing a proposed plan to serve as a strawman at the workshop:

Rick Lovdahl - Todd Pacific Shipyards - LA  
Jon Matthews - J. J. Henry Co., Inc.  
Douglas Martin - NASSCO  
James R. VanderSchaaf - Bath Iron Works

The workshop began by examining and defining the four areas of computerization focused on in the NCR report and as listed above. It was agreed that Data Transfer is:

- o An immediate problem
- o Best defined of the listed areas
- o Involved common Engineering Data Base and CAD/CAM Data Base Systems
- o Capable of being addressed practically
- o The proper place to begin an ongoing action plan.

The "Strawman" presented by Jim VanderSchaaf was based on the DDG 51 lead yard - follow yard relationship and principally addressed data transfer. After considerable discussion it was agreed that the "Strawman" contained essential elements that should be included in a formal proposal made to the Navy. However, it was also agreed that the proposal should accommodate the following added ingredients:

- o Definition of need.

In addition to the Navy's need to provide for the life cycle maintenance and distribution of thousands of drawings per ship, there is a pressing need for a coordinated effort to develop generic industry - wide/ Navy wide solutions. Valid but different solutions to the same problem will result if the needs are separately addressed by two or more parties.

- o Data transfer from the Navy (owner) to the lead yard
- o Transfer of data from lead and/or follow yards to the Navy
- o DDG 51 and SSN 21 programs should be coordinated.

The programs should benefit from each other and avoid, if possible, two solutions to a single problem.

- o DDG 51 and SSN 21 solutions must be developed in a manner and time frame that will support those ships' programs and schedules.
- o Resolution of DDG 51 data transfer problems should involve all potential follow yards.
- o SP-4 provides the mechanism for industry wide involvement.

'Practically speaking, the panel's involvement on the DDG 51 and SSN 21 programs could be advisory in nature.

- o ST-4 in conjunction with the Navy should develop generic standards building on the DDG 51 and SSN 21 experience.

- o The program thus established could be the beginning of a continuing effort to define and address evolving Navy- industry problems/opportunities related to computerization.
- o A defined deliverable
- o Estimated Cost
- o Proposed Schedule

John J. Nachtsheim and J. R. VanderSchaaf agreed to develop an unsolicited proposal based on the technical strawman prepared by Mr. VanderSchaaf and modified to incorporate the above features. The schedule for completion is August 26, 1985 which follows the preparation of this report.

'Panel SP-4 met on June 12, 1985 and endorsed the plans developed at the workshop the preceding day. It is planned to present the unsolicited proposal now under preparation to the Ship Production Committee for action during their meeting to be held during the Ship Production Symposium, September 10-13, 1985.

Panel SP-4 will meet again October 15-16, 1985 to plan next year's activity. It is important that the question of Navy - industry computerization be addressed. We believe a viable program will result from the program outlined above in that it does the following:

- o Addresses the need established in the National Research Council report.
- o Agrees with the objectives and direction included in Assistant Secretary of the Navy's letter of April 25, 1985.
- o Utilizes an existing industry technical organization thereby avoiding added administrative costs.
- o Has timely applicability to two important and current Navy programs.
- o Benefits from the schedule demands of the associated Navy programs.
- o Establishes a mechanism for continuing resolution of problems associated with the application of computer technology to shipbuilding and life cycle maintenance.

## CONCLUSION

This panel overview has described a very active program based on the premise that design is the first step in the production sequence. The need is not just better communication between the design and production functions, but rather the integration of those functions. This integration requires a full understanding of the ship design and building processes, an agreed strategy for building each ship, proper tools and the appropriate application of computer technology. It also requires the shipbuilder to be alert and innovative and amenable to constructive change.

Panel SP-4 logically addresses the problems of design production integration through a program of related projects and a sound planning program. Consider the following:

- ° The projects to develop a Design for Production Manual, investigate Interface Impacts in System to Zone Transition and provide a Workshop on Management of Advanced Technology in Shipbuilding are all intended to promote understanding of the tasks at hand.
- ° Work to develop a Product Work Clarification and Coding System and a Computer Aided Process Planning System are mutually supportive efforts to provide needed tools.
- ° Discovery of new tools and the better application of existing tools should result from the study on the Application of Advanced Measuring Techniques in Shipbuilding.
- ° Efforts to recognize and accommodate responsible change are reflected in the projects to investigate the Information Flow Requirements of Design and Procurement Functions, explore the Required Content and Format of Engineering Documentation and research Design/Planning Organizations.
- ° The appropriate application of computer technology is manifest in many of the program projects. The Product Work Classification and Coding System is required to be computer compatible, its use in the Computer Aided Process Planning System is obvious and the effort to Develop Specification Driven Piping Arrangement and Detail Drawings depends on the computer to discipline the selection of materials and configurations. The recently published "Software Tools for Shipbuilding Productivity" shows the way to cost effective integration of isolated computer applications and opens the door to growth in computer applications through a responsibly planned program.

- o Appropriate planning, as demonstrated by the panels involvement in the SPC approach to Navy - industry computerization, has included recognition of need, the location of required expertise and a reasonable approach to industry wide results.

Panel SP-4, Design Production Integration, is still working to assist U.S. Shipbuilding attain and maintain a competitive position in Time-Cost-Quality. Comments and questions will be welcomed by the panel and may be directed to:

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